Appendix B
Applications: Deformation Surveys of Locks and Dams
Central & Southern Florida Flood Control Project and Lock Dewatering Project

The following A-E Scope of Work illustrates technical requirements for deformation surveys of typical concrete lock structures. This sample project requires four types of deformation observations:

- Concrete crack measurements with inside micrometer
- Monolith deflection observations with a target micrometer
- Horizontal distance/coordinate trilateration observations with EDM
- Vertical settlement observations with precise parallel plate differential leveling

A project sketch is at Figure B-1.

TECHNICAL REQUIREMENTS

STRUCTURAL DEFORMATION MONITORING SURVEYS

CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL PROJECT

Spillway (Caloosahatchee River) S-77
WP Franklin Lock and Dam (Caloosahatchee River) S-79
St Lucie Lock and Dam (St. Lucie Canal) S-80
Port Mayaca Lock and Spillway (St. Lucie Canal) S-308B & S-308C
Moore Haven Lock (Caloosahatchee River) HGS-1

1. LOCATION OF WORK. The project is located in the vicinity of Clewiston, Florida.

2. SCOPE OF WORK.

2a. Perform Structural Deformation Monitoring Surveys (Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures--i.e., PICES) for determination of long-term structural movements. Measurements are made from points external to the structure to determine horizontal, vertical, alignment, concrete crack, and structural joint movement.

2b. The services to be rendered by the Contractor include all the work described in these technical requirements. Details not specifically described in these instructions are nevertheless a firm requirement if they can be identified as an item, or items, commonly a part of professional grade work of a comparative nature.

2c. The Contractor shall furnish all necessary materials, labor, supervision, equipment (other than furnished by Government), and transportation necessary to execute and complete all work required by these specifications.

2d. The Corps of Engineers, Survey Section shall be contacted the same day that the Contractor plans to commence the work. The POC for this project is Bynum Lunsford at (904) 232-1602.

2e. Rights-of-Entry must be obtained verbally and recorded in the field book before entering private property. Enter the name and address of the property owner contacted.

2f. COMPLIANCE. All Surveying and Mapping products and related work shall be in strict compliance with the applicable Engineering Manuals and with related technical standards and publications:

- EM-1110-1-1000 (Photogrammetric Mapping)
- EM 1110-1-1002 (Survey Markers and Monumentation),
- EM-1110-1-1003 (NAVSTAR Global Positioning System Surveying)
- EM-1110-2-1003 (Hydrographic Surveying)
- EM-1110-1-2909 (Geospatial Data And System)
- Tri-Services A/E/C CADD Standards, Spatial Data Standards and related Spatial Data Products
- Florida Statues Chapter 177, Chapter 472 and Rule Chapter 61G17, Florida Administrative Code.

3. FIELD SURVEY EFFORT. The area of work is outlined on Enclosure 1 Quad map, Enclosure 2 structure drawings, Enclosure 3 PICES historic report tabulation, Enclosure 4 technical requirements, and Enclosure 5 PICES detailed field measurement procedures.

3a. STRUCTURAL MOVEMENT MEASUREMENTS. Obtain horizontal EODM trilateration observations and vertical settlement measurements for S - 77 Spillway (Caloosahatchee River), vertical settlement measurements and horizontal alignment measurements for S - 79 WP Franklin Lock and Dam (Caloosahatchee River), vertical settlement measurements, horizontal EODM trilateration observations, and horizontal alignment measurements for S - 80 St Lucie Lock and Dam (St. Lucie Canal), horizontal alignment measurements, vertical settlement measurements, and crack measurements for S -308B & S - 308C Port Mayaca Lock and spillway (St. Lucie Canal), vertical settlement measurements for Moore Haven Lock (Caloosahatchee River) structures on Central And Southern Florida Flood Control Project.

3b. VERTICAL SETTLEMENT MEASUREMENTS

3b1. GENERAL. Vertical settlement is determined by precision differential leveling methods. Fixed reference points (bedrock benchmarks) are used to check for potential movement of various settlement points on the structure. Leveling shall be performed in conformance with the methods and accuracy of 1st-Order Geodetic Leveling.

3b2. PROJECT REQUIREMENTS AND INSTRUCTIONS. Each structure has a drawing showing the locations of the benchmarks, structure settlement points and instrument stands along with a tabular report indicating differential changes from previous reading and columns for this year's data set.

3b3. EQUIPMENT. The Government will furnish a first-order level, self supporting rods and turning pins.

3b4. RECORDING FORMATS. Micrometer leveling forms will be furnished. Level sketches and abstracts shall be prepared on 8 1/2" x 11" sheets.

3b5. OBSERVING PROCEDURES. Levels between reference BM's and structure points shall be run using single run/double rod precise leveling methods. Double run/double rod leveling methods are required when single run lines do not meet external misclosure tolerances.

3b6. INTERNAL MISCLOSURE TOLERANCES. Misclosure Tolerance = 3 mm x sqrt K (where K is distance in kilometers)

3b7. EXTERNAL MISCLOSURE TOLERANCE. If results do not compare with previously published report elevations double run line to verify that external misclosure excess is due to settlement of points and not due to internal problems.

3b8. INSTRUMENT CALIBRATION REQUIREMENTS. C - Factor calibrations shall be performed twice weekly, or at the beginning of leveling at a new structure, or daily if outside prescribed limits.

3b9. FIELD/OFFICE COMPUTATIONS AND REDUCTIONS. Leveling data sheets shall be checked in the field for resultant differential elevations for each run--sketches internal and external tolerances. Compile values into the current PICES report.

3c. HORIZONTAL EODM TRILATERATION OBSERVATIONS.

3c1. GENERAL. Distances to structural monitoring points are observed from one or more rigid instrument stands remote from (not influenced by) the structure. Observed structural movement vectors generally being perpendicular to the structures probable plane of failure.

3c2. PROJECT REQUIREMENTS AND INSTRUCTIONS. Each structure has a drawing showing the locations of the benchmarks, structure reference points and instrument stands along with a tabular report indicating differential changes from previous reading and columns for this year's data set.

3c3. EQUIPMENT. If available a short-range precision Electronic Distance Meter with numbered reflector and calibrated over a baseline. If unavailable equipment will be furnished by the Government.

3c4. RECORDING FORMATS. Standard field survey books, showing readings, atmospheric conditions, height, computations and reductions.

3c5. OBSERVING PROCEDURES. Two sets of five observations.

3c6. INTERNAL REJECTION CRITERIA. A spread for mean of 10 observations (2 sets of 5) shall not vary by more than +/- 0.002 meter' otherwise, reobserve series.

3c7. EXTERNAL REJECTION CRITERIA. Change of +/- 0.005 meter from previous PICES length observations.

3c8. CALIBRATION REQUIREMENTS. Calibration must be performed with each available reflector and the resultant system constants for the instrument/reflector pair clearly identified by serial numbers.

3c9. FIELD/OFFICE COMPUTATIONS AND REDUCTIONS. Final corrected (atmospheric, system constant, eccentricities, slope & elevation) horizontal distances will be computed and verified/checked in the field. Compile values into the current PICES report.

3d. HORIZONTAL ALIGNMENT DEFLECTION MEASUREMENTS.

3d1. GENERAL. Horizontal deformation of points on structural sections are monitored by observing magnitudes (by micrometer) with precision theodolite relative to fixed pints on a baseline not influenced by the structure.

3d2. PROJECT REQUIREMENTS AND INSTRUCTIONS. Each structure has a drawing showing the locations of the benchmarks, structure reference points and instrument stands along with a tabular report indicating differential changes from previous reading and columns for this year's data set.

3d3. EQUIPMENT. If available Wild T-2 with force centering tribrach targets, plug inserts and alignment micrometer. If unavailable equipment will be furnished by the Government.

3d4. RECORDING FORMATS. Standard field survey books, showing readings, atmospheric conditions, height, computations and reductions.

3d5. OBSERVING PROCEDURES. Two sets of five observations with micrometer left and right.

3d6. INTERNAL REJECTION CRITERIA. Plus or minus 0.02" spread from mean.

3d7. EXTERNAL REJECTION CRITERIA. None.

3d8. CALIBRATION REQUIREMENTS. None.

3d9. FIELD/OFFICE COMPUTATIONS AND REDUCTIONS. Mean left and right micrometer observations to the nearest 0.001". Variation for left or right mean in the 5 set series should not exceed +/- 0.02; if so reobserve. Compile values into the current PICES report.

3e. CRACK MEASUREMENTS.

3e1. GENERAL. Measurements are made relative to grouted plugs set across a concrete crack or structural construction joint.

3e2. PROJECT REQUIREMENTS AND INSTRUCTIONS. Each structure has a drawing showing the locations of the benchmarks, structure reference points and instrument stands along with a tabular report indicating differential changes from previous reading and columns for this year's data set.

3e3. EQUIPMENT. The Government will furnish Starrett Inside Micrometer

3e4. RECORDING FORMATS. Standard field survey books, showing readings, computations and reductions.

3e5. MEASUREMENT PROCEDURES. Read Micrometer in both directions between crack plugs and mean results to the nearest 0.001".

3e6. INTERNAL REJECTION CRITERIA. One thousand inch between each direction; +/- 0.001" from nominal calibration bar.

3e7. EXTERNAL REJECTION CRITERIA. None.

3e8. CALIBRATION REQUIREMENTS. None.

3e9. FIELD/OFFICE COMPUTATIONS AND REDUCTIONS. Compile checked and verified values into the current PICES report.

3e. CONTROL. The vertical reference datum is assumed 100.00 meters. A horizontal reference datum is not required.

3f. All original field notes shall be kept in standard pocket size field books and shall become the property of the Government. The first four pages of the field books shall be reserved for indexing and the binding outside edge shall be free of all marking.

4. OFFICE REVIEW AND COMPUTATIONS. The Contractor shall make the necessary computations to verify the correctness of all measurements and apply the proper theory of location in accordance with the law or precedent and publish the results of the survey. The contractor shall submit the original field notes and horizontal and vertical abstract (computation abstract) to Survey Section.

5. CONTRACTOR QUALITY CONTROL/GOVERNMENT QUALITY ASSURANCE.

- The Contractor is responsible for quality control.
- Government personnel may perform inspections of the Contractor's field operations at any time during the prosecution of this work. The Contractor shall explain calibration procedures and operational activities related to their field effort.
- If during the Government's review of the Contractor's products it becomes apparent that little or no review has been done, the Government will return the entire project to the Contractor for correction.

6. DELIVERIES. On completion, all data required shall be delivered or mailed to Design Branch, Survey Section at the address shown in the contract, and shall be accompanied by a properly numbered, dated and signed letter or shipping form, in duplicate, listing the materials being transmitted. All digital data shall be submitted on CD-ROM's. All costs of deliveries shall be borne by the Contractor. Items to be delivered include, but are not limited to the following:

6a. Horizontal and Vertical Field Books.
6b. Bound 8-1/2" x 11" abstracts, reductions, computations, adjustments, and tabular summaries fully annotated with independent checks.
6c. PICES report tabulations.

SUBMITTED BY_____B. Lunsford

Engineering Division
Design Branch

SUBJECT: Contract No. DACW17-99-D-0046

Mr. John Morgan
Morgan & Ekland, Inc.
8745 U. S. Highway 1
Wabasso, Florida 32970

Mr. Morgan:

Reference contract number DACW17-99-D-0046 for Surveying and Mapping Services. The Government desires to execute a delivery order under subject contract for the following project:

STRUCTURAL DEFORMATION MONITORING SURVEYS
CENTRAL AND SOUTHERN FLORIDA
FLOOD CONTROL PROJECT
CLEWISTON, FLORIDA (SURVEY NO. 00-211)

Please review the enclosed Scope of Work outlining the Technical Requirements and submit an itemized fee proposal for this work within 10 working days of receipt of this document. Please furnish this fee proposal to the attention of the Chief, Design Branch.

This request does not constitute a notice to proceed for the Delivery Order. Please do not commence work or incur any costs chargeable to the Government. You are cautioned that preparation of this fee proposal is entirely at your own risk and the Government can assume no obligation for payment of any related expenses incurred by your firm.

Bynum Lunsford of the Survey Section is the point of contact. Please call him at 904-232-1602 if you have questions or need additional information.

Sincerely,

Walter Clay Sanders, P.E
Assistant Chief, Engineering Division

Enclosures

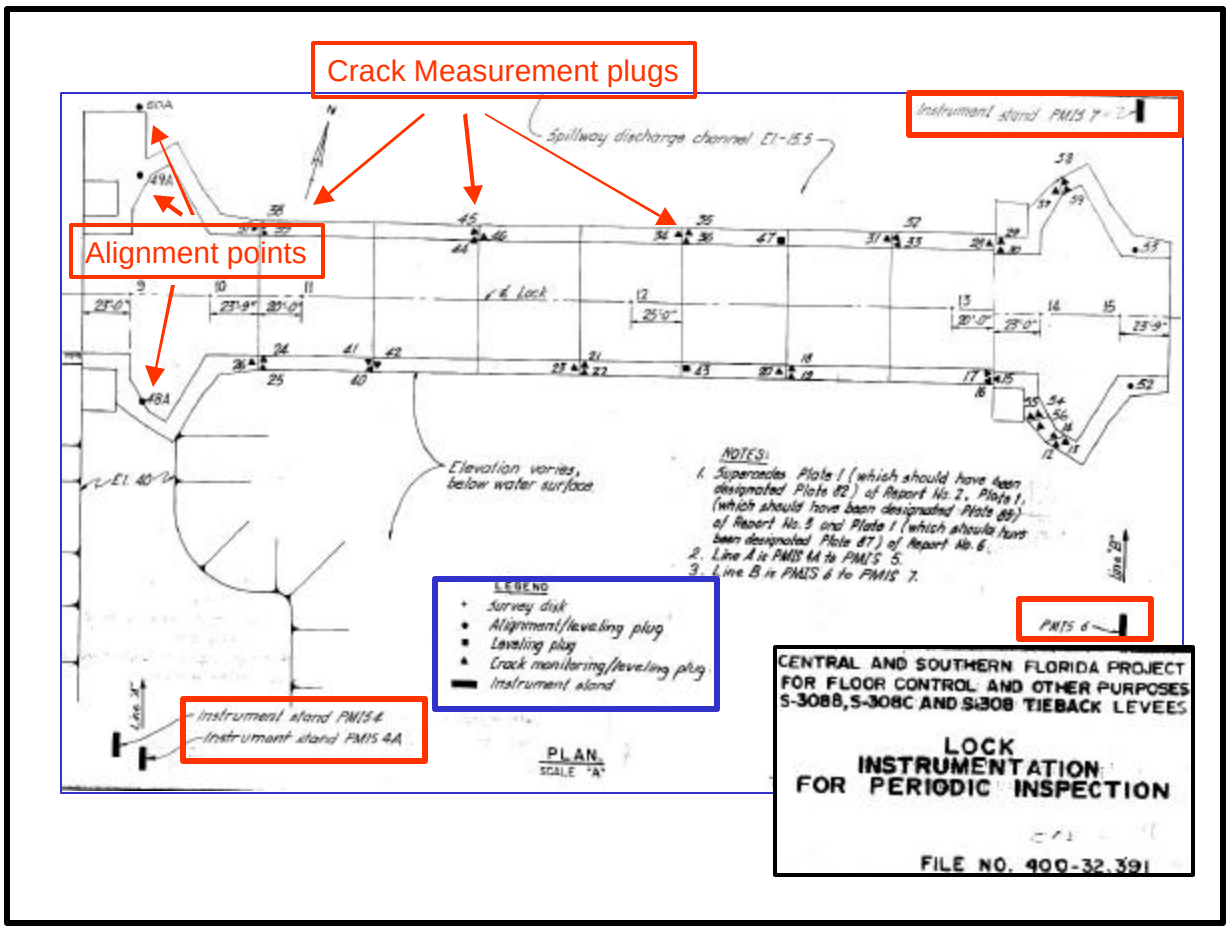

Figure B-1. Structural monitoring and target points for Port Mayaca Lock and Spillway, Central & Southern Florida Flood Control Project.

Surveying for Lock Structure Dewatering
Lock & Dam No. 4

The following project illustrates plans and procedures for deformation surveys of concrete lock structures. The most common lock structure uses concrete gravity walls founded on either piling or rock. Maintenance of navigation locks requires full dewatering of the lock chamber and most flow passages. Monitoring the relative position of the gate monoliths and wall movement is made to ensure safety and stability of the structure. This example represents a typical wall monitoring operation for lock dewatering. Deformation surveys of this type are usually short-term and include the following types of observations.

- Monolith deflection observations with inside micrometer
- Horizontal distance/coordinate observations with surveying instruments.
- Vertical settlement observations with differential leveling
- Water level measurements read inside the lock chamber
- Peizometer and well observations on the landside embankment

1. Project Location and Description.

Lock No. 4 is located in Alma, Wisconsin, at river mile 752.8 on the upper Mississippi River--Figures B-2 and B-3. The lock is 600 feet long by 110 feet wide, and raises and lowers traffic 7 feet. The dam is 6,867 feet long including movable gate sections and earth fill dike. The movable gate section consists of six roller gates and 22 tainter gates. Pool 4 formed by this dam is 44.1 river miles encompassing 22 mile long Lake Pepin, a natural lake in the main channel of the Mississippi. Lock and Dam No. 4 was completed in 1935, with major rehabilitation completed in 1994 adding 50 years to its serviceability.

Figure B-2. Aerial View of Lock and Dam No. 4, Alma, WI.

2. Preparation and General Procedures.

Work will be conducted in 2 – 12 hour shifts, each consisting of Party Chief, Instrumentman, Rodman. The Wild T2002 will be checked and adjusted 48 hours before surveys start and according to manufacturers specifications. Tribrachs will be adjusted before starting instrumentation surveys. Barometric pressure (station pressure) will recorded every hour on the hour. Temperature will be recorded every hour on the hour. Atmospheric correction (combination of pressure and temperature) will be recorded and applied to the instrument before each session of measurements. One person will measure the wells and piezometers, the gauge inside the chamber and number and size of pumps that are running every two hours.

2. Equipment List.

Wild Leica TC2002, Di2000 With 2 Charged Batteries.
EDM Battery Charger
2 Single Prisms
8 Tripods
8 Tribrachs
30 Sand Bags ½ Filled With Dry Sand
Barometer (Station Type, Not Sea Level)
Thermometer
Wild TC2002 Hand Book With Graphs For Environmental Corrections
Piezometer Gauge Reader (Eng. Div)
Small Plastic Bags To Cover Tribrachs
Umbrella To Keep Instrument Dry If Raining
Water Gauge And Weight For Inside Chamber
Roto Hammer, Anchors, Washers And Pedestals
Lead Wool 15#
4 Flashlights
Hammer And Chisel
10 lb. Maul
Field Books
Warm, Dry Clothes

3. Instrumentation Procedures.

The following instrumentation procedures were followed during the Lock #4 dewatering project 2000. (Refer to Figures B-4 through B-9).

a. A new baseline will be set along the landside parking lot and Hwy 35. The existing baseline monuments must be abandoned for a location greater than 25’ from the Railroad tracks. The new base line monuments will be 1 inch steel rebar 4 feet in length with punch holes. They will be aligned dead center with each other. These monuments will be checked once per day to ensure there is no movement.

b. Set Leica TC2002 at monument 0+00 on the Intermediate wall, back sight monument L-3 (Station 0+00) on the old baseline. Then turn right angles up and down the Intermediate wall (I-wall) and set lead plugs with brass tacks at station 2+97.09A, 3+65.86A, 4+01.32A, 1+73.68B and 2+68.18B. Align tacks dead center with each other.

c. Set the instrument at each of the above stations on the I-wall and turn right angles across the lock chamber and set stainless steel pedestals. Station 0+00 on the landwall is a brass disc, do not set a

pedestal here. At landwall station 4+01.32A and 3+65.86A, set a new pedestal at each station on Control Building. These pedestals on the building will be heated and bent to the vertical position on the building.

d. With the instrument set at Stations 0+00 on the I-wall, back sight monument L-3 (Station 0+00) on the old base line and plunge line ahead to the parking lot to 0+00 on the new base line. Make punch hole.

e. Move the instrument to station 0+00 on the new base line, back sight station 0+00 on the I-wall. Turn right angles to the other two base line monuments and make punch marks dead center with each other.

f. All measurements will be made from the I-wall to the landwall, to the new base line, and to the building pedestals.

g. Start with measuring the alignment on the new base line each day for three days.

- Move the instrument to I-wall station 4+01.32A, measure the distance in meters to station 4+01.32A on the opposite landwall and to station 4+01.32A on the building. Measure the distance 5 times to each station and record and average the readings.

- Move the instrument to I-wall station 3+65.86A and measure the distance in meters to station 3+65.86A on the landwall and to the building. Measure the distance 5 times to each station and record and average the readings.

- Move the instrument to I-wall station 2+97.09A and measure the distance in meters landwall station 2+97.09A and to the new base line station 2+97.09A. Measure the distance 5 times to each station and record and average the readings.

- Move the instrument to I-wall station 0+00 and measure the distance in meters to landwall station 0+00 and to the new base line 0+00. Measure the distance 5 times to each station and record and average the readings.

- Move the instrument to I-wall station 1+73.68B and measure the distance in meters to landwall station 1+73.68B. Measure the distance 5 times to each station and record and average the readings.

- Move instrument to I-wall station 2+68.18B and measure the distance in meters to landwall station 2+68.18B on the landwall. Measure the distance 5 times to each station and record and average the readings.

This procedure will be repeated two to three days before de-watering to initialize the system. When the drawdown starts, this system will be measured every two hours during drawdown. After the lock is de-watered, the system will be measured once per day for five days, then once per week thereafter until the chamber is refilled, then once per day for two days. The monitoring will then be completed.

4. Special Instructions.

The water inside the lock chamber is not to drop faster than ½ foot per hour. This is a very critical task and pumps may need to be shut down to maintain this ½ foot per hour. There will be 6 – 8 inch Flyght pumps and 2 – 6 inch Flyght pumps operating to dewater the lock. If the water is dropping at a faster rate,

shut down the 6 inch pumps first. Observe the water gauge in the chamber for the next hour and adjust the number of operating pumps accordingly.

While observing the monitoring system and 0.006 m of movement is determined, notify the Structural Branch (POC and phone numbers are posted) that you have detected movement of 6 mm or more and then keep repeating the measurements at that station every ½ hour, or until instructed otherwise.

The water level inside the wells and in the piezometers are very critical. Try to maintain the target level on the form provided. If large increases are detected, notify Geotechnical Branch (POC and phone numbers are posted) that you have detected a large change in water levels. If this happens, you will need to measure the water levels more frequently, and possibly adjust the valves on the wells.

Figure B-3. Lock and Dam No. 4 showing Intermediate Wall and Land Wall.

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Date	Time	Temp	Pumps	Gauge Reading In Chamber	Date	Time	Temp	Pumps	Gauge Reading in Chamber
12/10/00	2200	-1	4 - 8" Flyght	14.74	12/11/00	2230		5 - 8" Flyght	8.30
12/11/00	2400	-1	5 - 8" Flyght	14.60		2300		5 - 8" Flyght	8.20
	30	-1	5 - 8" Flyght	14.60		2330		5 - 8" Flyght	8.10
	100	-1	5 - 8" Flyght	14.60		2400		5 - 8" Flyght	8.10
	130	-1	5 - 8" Flyght	14.30	12/12/00	30		5 - 8" Flyght	7.9
	200	-1	5 - 8" Flyght	14.10		100		5 - 8" Flyght	7.9
	230	-1	5 - 8" Flyght	14.00		230		5 - 8" Flyght	7.5
	300	-1	5 - 8" Flyght	13.80		300		5 - 8" Flyght	7.5
	330	-2	5 - 8" Flyght	13.70		330		5 - 8" Flyght	7.2
	400	-2	5 - 8" Flyght	13.60		400		5 - 8" Flyght	7.0
	430	-2	5 - 8" Flyght	13.60		430		5 - 8" Flyght	6.9
	500	-2	5 - 8" Flyght	13.50		500		5 - 8" Flyght	6.5
	530	-2	5 - 8" Flyght	13.40		530		5 - 8" Flyght	6.4
	600	-2	5 - 8" Flyght	13.40		600	-7	5 - 8" Flyght	6.3
	630	-2	5 - 8" Flyght	13.40		630	-7	5 - 8" Flyght	6.3
	700	-2	5 - 8" Flyght	13.30		700	-10	5 - 8" Flyght	6.3
	730	-2	5 - 8" Flyght	13.30		730	-10	5 - 8" Flyght	6.3
	800	-2	5 - 8" Flyght	13.20		800	-10	5 - 8" Flyght	6.3
	830	-2	5 - 8" Flyght	13.20		830	-10	5 - 8" Flyght	6.3
	900	-2	5 - 8" Flyght	13.00		900	-3	5 - 8" Flyght	6.1
	1100	0	5 - 8" Flyght	12.40		1000	-3	5 - 8" Flyght	5.8
	1130	1	5 - 8" Flyght	12.00		1030	-3	4 - 8" Flyght	5.5
	1200	3	5 - 8" Flyght	11.70		1100	-2	4 - 8" Flyght	5.4
	1230	3	5 - 8" Flyght	11.50		1230	0	4 - 8" Flyght	5.0
	1300	2	5 - 8" Flyght	11.30		1330	1	5 - 8" Flyght	4.8
	1330	3	5 - 8" Flyght	11.15		1400	-1	5 - 8" Flyght	4.6
	1400	3	5 - 8" Flyght	11.00		1430	-1	5 - 8" Flyght	4.5
	1430	3	5 - 8" Flyght	10.80		1600	-2	5 - 8" Flyght	3.9
	1500	2	5 - 8" Flyght	10.50		1630	-2	5 - 8" Flyght	3.7
	1530	2	5 - 8" Flyght	10.35		1700	-3	5 - 8" Flyght	3.5
	1600	2	5 - 8" Flyght	10.10		1730	-4	5 - 8" & 1 - 6"	3.3
	1630	2	5 - 8" Flyght	9.90		1800	-4	5 - 8" & 1 - 6"	3.1
	1700	2	5 - 8" Flyght	9.70		1830	-4	5 - 8" & 1 - 6"	2.8
	1730	2	5 - 8" Flyght	9.50		1900	-4	5 - 8" & 1 - 6"	2.6
	1830	2	5 - 8" Flyght	9.30		2000	-4	5 - 8" & 1 - 6"	2.3
	1900	2	5 - 8" Flyght	9.10		2030	-3	5 - 8" & 1 - 6"	1.8
	1930		5 - 8" Flyght	9.10		2230	-3	3 - 8" & 1 - 6"	1.5
	2000		5 - 8" Flyght	8.70	12/13/00	30	-3	3 - 8" & 1 - 6"	1.1
	2030		5 - 8" Flyght	8.60		100	-3	2 - 8" & 1 - 6"	Iced up
	2100		5 - 8" Flyght	8.50		400	-2	2 - 8" & 1 - 6"	Iced up
	2130		5 - 8" Flyght	8.40		600	-2	2 - 8" & 1 - 6"	Dewatered
	2200		5 - 8" Flyght	8.30					

Figure B-4. Water level (Gauge) readings recorded during dewatering operations.

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Lock #4 Monitoring Measurements

NEW BASELINE SURVEY (NBL)

Date	Time	Temp F	Press.	0+00 NBL	2+97.09A NBL	3+65.86A NBL
8-Dec-00	**1300**	**12 Deg F**	**30.1**	**0.00**	**0.00**	**0.00**
9-Dec-00	**1400**	**12 Deg F**	**30.1**	**0.00**	**0.00**	**0.00**

INITIAL SURVEY (Distances in Meters)

				0+00 l wall	0+00 l wall	2+97A l wall	2+97A l wall	3+66A l wall	3+66A l wall	4+01A l wall	4+01A l wall	1+74B l wall	2+68B l wall
				0+00 L wall	0+00 NBL	2+97A L wall	2+97A NBL	3+66A L wall	3+66A Bldg	4+01A L wall	4+01A Bldg	1+74B L wall	2+68B L wall
8-Dec-00	1400	12 Deg F	30.1	35.2018	86.3114	35.5933	86.3105	34.7282	42.1385	34.7468	42.1747	34.6993	34.6021
9-Dec-00	900	16 Deg F	30.0	35.2027	86.3095	35.5945	86.3125	34.7290	42.1395	34.7477	42.1742	34.6998	34.6065
9-Dec-00	1030	16 Deg F	30.0	35.2042	86.3092	35.5945	86.3122	34.7292	42.1386	34.7463	42.1752	34.7014	34.6065
INITIAL SURVEY (Average Values)				**35.2029**	**86.3100**	**35.5941**	**86.3117**	**34.7288**	**42.1389**	**34.7469**	**34.1750**	**34.7002**	**34.6050**

MONITORING SURVEY

				0+00 l wall	0+00 l wall	2+97A l wall	2+97A l wall	3+66A l wall	3+66A l wall	4+01A l wall	4+01A l wall	1+74B l wall	2+68B l wall
Date	Time	Temp F	Press.	0+00 L wall	0+00 NBL	2+97A L wall	2+97A NBL	3+66A L wall	3+66A Bldg	4+01A L wall	4+01A Bldg	1+74B L wall	2+68B L wall
11-Dec-00	2400	-1	30.05	35.2018	86.3090	35.5990	86.3122	34.7293	42.1395	34.7488	42.1785	34.6976	34.6050
11-Dec-00	200	-1	30.05	35.2032	86.3090	35.5935	86.3127	34.7291	42.1383	34.7557	42.1735	34.6981	34.6030
11-Dec-00	400	-2	30.05	35.2031	86.3086	35.5954	86.3140	34.7355	42.1440	34.7465	42.1736	34.6981	34.6037
11-Dec-00	600	-2	30.05	35.2020	86.3084	35.5959	86.3145	34.7313	42.1397	34.7471	42.1746	34.6996	34.6047
11-Dec-00	800	-2	30.05	35.2021	86.3082	35.5939	86.3136	34.7300	42.1400	34.7491	42.1763	34.6987	34.6031
11-Dec-00	1000	1	30.05	35.2029	86.3084	35.5951	86.3132	34.7320	42.1405	34.7494	42.1773	34.6983	34.6033
11-Dec-00	1200	3	30.00	35.2049	86.3078	35.5941	86.3119	34.7294	42.1392	34.7488	42.1769	34.6980	34.6042
11-Dec-00	1400	3	29.95	35.2038	86.3078	35.5947	86.3126	34.7292	42.1389	34.7479	42.1776	34.6986	34.6038
11-Dec-00	1600	2	29.95	35.2007	86.3077	35.5930	86.3126	34.7304	42.1396	34.7475	42.1752	34.6984	34.6030
11-Dec-00	1800	2	29.97	35.2015	86.3076	35.5945	86.3131	34.7295	42.1419	34.7482	42.1771	34.6978	34.6038
11-Dec-00	2000	2	29.98	35.2006	86.3075	35.5954	86.3111	34.7301	42.1402	34.7475	42.1753	34.6994	34.6028
11-Dec-00	2200	0	29.95	35.2015	86.3075	35.5942	86.3136	34.7288	42.1395	34.7466	42.1765	34.6970	34.6028
12-Dec-00	2400	-1	29.90	35.2025	86.3079	35.5949	86.3130	34.7326	42.1390	34.7470	42.1722	34.6999	34.6044
12-Dec-00	200	-1	29.95	35.2036	86.3079	35.5941	86.3136	34.7298	42.1377	34.7471	42.1746	34.6972	34.6042
12-Dec-00	400	-7	30.00	35.2040	86.3084	35.5937	86.3150	34.7287	42.1388	34.7441	42.1744	34.6989	34.6021
12-Dec-00	600	-7	30.09	35.2011	86.3083	35.5936	86.3122	34.7288	42.1404	34.7425	42.1749	34.6978	34.6030
12-Dec-00	800	-10	30.25	35.2024	86.3072	35.5949	86.3135	34.7288	42.1412	34.7430	42.1753	34.6990	34.6038
12-Dec-00	1000	-1	30.30	35.2021	86.3076	35.5941	86.3145	34.7315	42.1415	34.7497	42.1769	34.7000	34.6044
12-Dec-00	1200	9	30.30	35.2024	86.3077	35.5952	86.3136	34.7305	42.1417	34.7493	42.1770	34.6995	34.6053
12-Dec-00	1400	6	30.30	35.2024	86.3075	35.5945	86.3126	34.7314	42.1413	34.7486	42.1763	34.6996	34.6058
12-Dec-00	1600	0	30.30	35.2032	86.3075	35.5960	86.3139	34.7315	42.1411	34.7496	42.1760	34.7012	34.6060
12-Dec-00	1800	-4	30.30	35.2037	86.3077	35.5963	86.3142	34.7308	42.1412	34.7481	42.1755	34.7007	34.6051
12-Dec-00	2000	-4	30.30	35.2057	86.3075	35.5940	86.3124	34.7307	42.1422	34.7475	42.1780	34.6999	34.6027
12-Dec-00	2200	-3	30.30	35.2005	86.3072	35.5951	86.3132	34.7308	42.1389	34.7456	42.1727	34.6984	34.6019
13-Dec-00	2400	-3	30.30	35.2005	86.3073	35.5938	86.3125	34.7302	42.1403	34.7464	42.1726	34.7002	34.6024
13-Dec-00	200	-2	30.00	35.2004	86.3071	35.5966	86.3133	34.7329	42.1402	34.7473	42.1753	34.6996	34.6038
13-Dec-00	600	-2	30.00	35.2004	86.3068	35.5966	86.3121	34.7318	42.1401	34.7481	42.1750	34.6986	34.6046

Figure B-5. Distances measured across lock chamber walls using conventional instrumentation.

GPS Wall Monitoring - Baselines (meters)

Hours	I-wall 1	I-wall 2	I-wall 3	L-wall 1	L-wall 2	L-wall 3
0	113.9190	53.1768	112.2112	104.0844	25.1903	101.7617
2	113.9219	53.1775	112.2121	104.0818	25.1895	101.7612
5	113.9189	53.1768	112.2126	104.0806	25.1915	101.7619
9	113.9199	53.1789	112.2127	104.0792	25.1914	101.7589
15	113.9189	53.1782	112.2128	104.0815	25.1906	101.7589
22	113.9189	53.1739	112.2113	104.0825	25.1894	101.7599
28	113.9180	53.1775	112.2163	104.0823	25.1890	101.7619
35	113.9160	53.1768	112.2126	104.0798	25.1904	101.7596

Figure B-6. Processed GPS baselines from the reference station.

GPS Wall Monitoring - Differences (millimeters)

Hours	I-wall 1	I-wall 2	I-wall 3	L-wall 1	L-wall 2	L-wall 3
0	0.1	-0.3	-1.5	2.9	0.0	1.2
2	3.0	0.4	-0.8	0.7	-0.8	0.9
5	0.0	-0.3	-0.3	-0.5	1.2	1.6
9	1.0	1.8	-0.2	-1.9	1.1	-1.4
15	0.0	1.1	-0.1	0.4	0.3	-1.4
22	0.0	-3.2	-1.6	1.4	-0.9	-0.4
28	-0.9	0.4	3.4	1.2	-1.3	1.6
35	-2.9	-0.3	-0.3	-1.3	0.1	-0.7

Figure B-7. Processed GPS baseline differences from the initial survey.

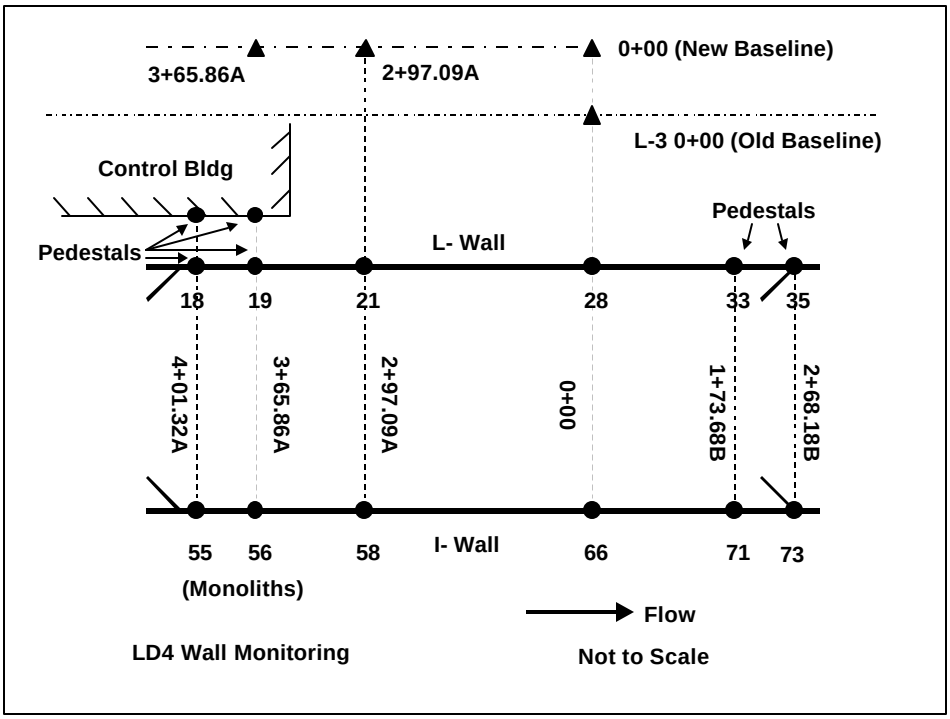

Figure B-8. Instrumentation Plan and Measurement Scheme for conventional deformation surveys.

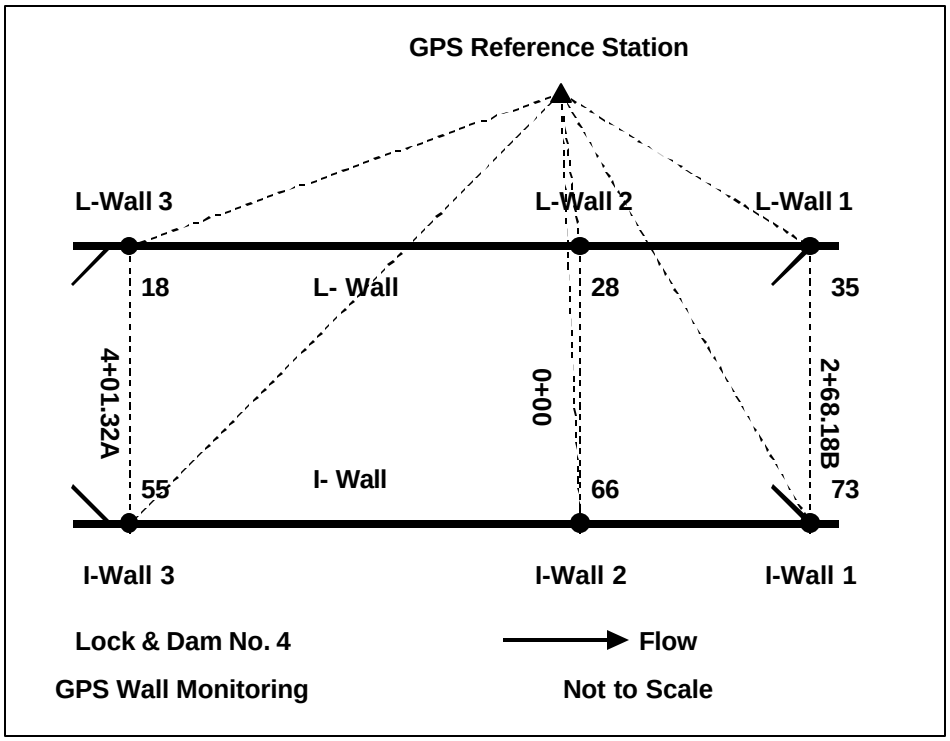

Figure B-9. Instrumentation Plan and Measurement Scheme for GPS-based deformation surveys.